



State of Illinois
Department of Commerce and Economic Opportunity

THE EFFECTS OF SULFUR DIOXIDE EMISSION



REGULATIONS ON THE ILLINOIS COAL INDUSTRY

The Clean Air Act and the Amendments that followed curtailed the use of Illinois coal and subsequently protected the environment. Advances in coal-related technology research, development and demonstration spurred on by state and federal regulations over the past 30+ years have proven that coal can be used more cleanly than ever before.

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The Effects of Emission Regulations on the Illinois Coal Industry

Coal is a hydrocarbon – a fossil fuel containing impurities such as mercury, sulfur and heavy metals. It has a high heat energy value and has been a mainstay U.S. and global fuel for more than 200 years.

Coal is affordable and abundant in Illinois. The energy bound up in coal largely is used to produce steam that can spin the blades of a turbine to generate electricity.

The Clean Air Act and the amendments that followed curtailed the use of Illinois coal and subsequently protected the environment. Advances in coal-related technology research, development and demonstration, spurred on by state and federal regulations over the past 30+ years, have proven that coal can be used more cleanly than ever before.

Many of the impurities within coal can be removed prior to combustion. Other impurities, or pollutants, can only be removed during or after combustion. The impurities removed from coal must then be handled in such a way as to not contaminate the air, water or land. The Department of Commerce and Economic Opportunity, Office of Coal Development is part of this overall effort.

The electricity produced from coal is harnessed, sold and delivered 24/7, providing a secure source of energy to more than 40% of the homes and businesses in the United States.ⁱ Energy security, the uninterrupted availability of energy sources at an affordable price, fueled the industrial revolutions of the past. For the foreseeable future, coal, oil and natural gas will continue to fuel the growing economies of China, India and other developing economies. Yet here in the U.S., there are more than 143 laws that govern the recovery and use of these fuels.ⁱⁱ

Meet the stakeholders

As of January 1, 2014, nine coal producers operated 21 coal mines in Illinois. The mines are located in 14 counties and directly employed more than 4,000 persons. Independent contractors at these mines employ 300 or more persons. The average annual wage of a coal miner in Illinois is \$82,869.

Transportation workers from Illinois mines hauled more than 50 million tons of coal by truck, train or barge in 2013. Other companies deliver necessary supplies, parts and materials to the mines for everyday operation.

Stakeholders also include those who depend on three Illinois *coal-fueled electric generators* equipped with state-of-the-art emission controls that serve more than 2.7 million customers. They used nearly 8 million tons of coal from nearby Illinois mines in 2013.

Regulations affecting the Illinois coal industry

A goal of reducing annual sulfur dioxide (SO₂) emissions by 10 MT below 1980 levels was set in Title IV of the Clean Air Act (CAAA). A list of laws that have been passed or have recently been proposed to cut emissions from coal-fueled power plants can be found on page 3.

The effects of SO₂ emission regulations on the coal industry

Enforcing the CAAA hit the mining of high-sulfur coal in Illinois more than the producers of any other region. Power plants in Coffeen, Newton, Edwards, Joppa, and Kincaid were among those that were switched to lower sulfur coal from the Powder River Basin in Wyoming.

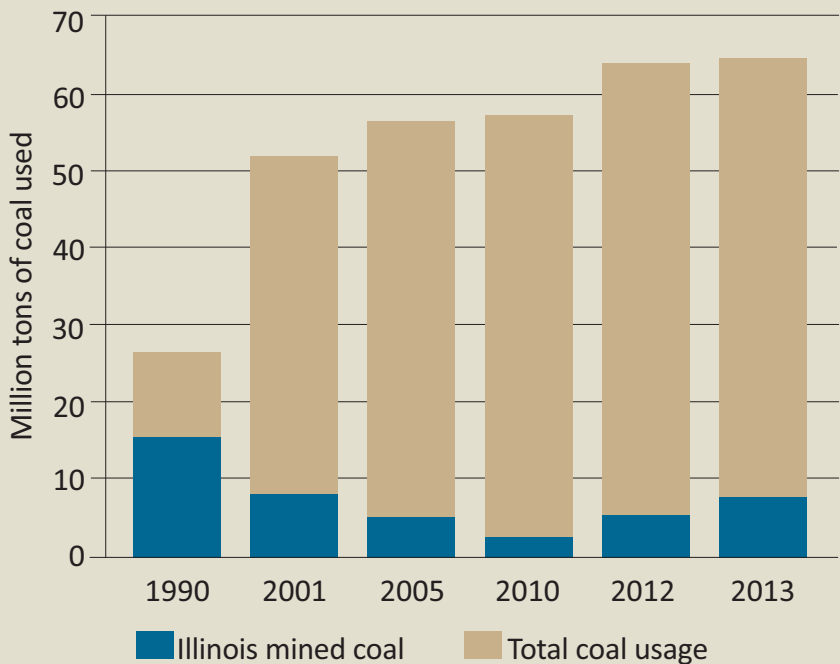
In 1990, before the CAAA, Illinois utilities purchased nearly 15.4 million tons, or 61%, of their coal from Illinois



coal mines. These mines employed 10,129 workers.ⁱⁱⁱ By 2001, those numbers had dropped to 8.1 million tons, and 3,516 workers. By 2005, Illinois coal usage by in-state power plants dropped to 9.7% of the 2001 tonnage. By 2010 Illinois power plants were fueled with only 4.5% of coal from Illinois mines. Coal mine employment hovered around 3,560.

Benefitting from this dramatic fuel-switching were mines producing low-sulfur coal in Wyoming.

Change in Coal Use by Illinois Utilities



The use of Illinois mined coal decreased, while the overall use of coal in Illinois more than doubled between 1990 and 2013.

Recent statistics show Illinois coal usage rebounding to 8.7% in 2012 and to 13% in 2013. This is due to the new 1600 megawatt Prairie State Generating Station in Washington County. Illinois mine employment remains near 4,000 plus approximately 300 contract employees.

Other electric generators in Illinois use lower sulfur coal from out-of-state mines to meet federal SO₂ regulations. With the passage of Illinois' Combined Pollutant Law in 2006 these generators were faced with developing another strategy to reduce pollution.

Mercury and Air Toxics Standards

Operators of coal-fired power plants not just in Illinois but throughout the United States are currently evaluating options to comply with the Mercury and Air Toxics Standards (MATS) that were passed in 2011. The equipment needed to control acid and toxic metal emissions, such as flue gas desulfurization (FGD) and dry sorbent injection (DSI), can also effectively remove sulfur dioxide emissions.

Under MATS by April 2015, coal-fired power plants must incorporate the maximum achievable control technologies (MACT) to control the emissions of acid gases, toxic metals, and mercury.

FGD with a fabric filter or an advanced electrostatic precipitator will likely qualify as the MACT for toxic metals. If a DSI system is used to control the acid gases, then a fabric filter must be included to remove the appropriate level of toxic metals to complement the performance of the DSI system.

State environmental permitting agencies can grant one-year compliance exemptions beyond 2015. Many states are likely to use this flexibility.

The control equipment needed to reduce mercury is driven by the type of coal burned and the plant configuration. In some cases an existing FGD scrubber and selective catalytic reduction system (SCR) can lower mercury emissions to the point where no additional controls are needed. In other cases, activated carbon injection (ACI) systems may be necessary to bring plants into compliance.

The effects of MATS regulation

The costs of MACT play a significant role in retrofitting-or-retirement decisions that have power marketers, as well as coal operators, watching with keen interest.

FGD scrubbers have higher capital costs but lower operating costs than DSI systems, along with a higher

Reducing Emissions by Establishing Federal Regulations

1970 Clean Air Act

1990 Clean Air Act Amendments

1990 National Ambient Air Quality Standards reviewed every 5 years

1995 Phase I Acid Rain Program

2000 Phase II Acid Rain Program

2005 Clean Air Interstate Rule – replaced in 2011 with CSAPR

2006 Illinois Combined Pollutant Law*

2010 Mandatory Reporting of Greenhouse Gases

2011 Cross State Air Pollution Rule (CSAPR)

2011 Mercury & Air Toxics Standards (MATS)

2011 Greenhouse Gas Tailoring Rule

2013 EPA updates MATS for new power plants

2013 Proposed Carbon Pollution Standards for New Power Plants

2013 Clean Energy Standard

2014 HB 3826, the Electricity Security and Affordability Act

*State of Illinois law not federal law

Technology Available to Control Emissions

Pollutant addressed	Existing control technologies to address toxic pollutants
Mercury	Selective Catalytic Reduction (SCR) with Flue-gas Desulfurization (FGD), Activated Carbon Injection (ACI), ACI with Fabric Filter (FF) or Electrostatic Precipitators (ESP)
Non-mercury metals	FF, ESP
Acid gases	FGD, Dry Sorbent Injection (DSI), DSI with FF or ESP
Sulfur Dioxides (SO ₂)	FGD, DSI
Nitrogen Oxides (NO _x)	Low-NO _x burners; SCR
Ultra-fine particulate matter (PM)	FF, wet ESP

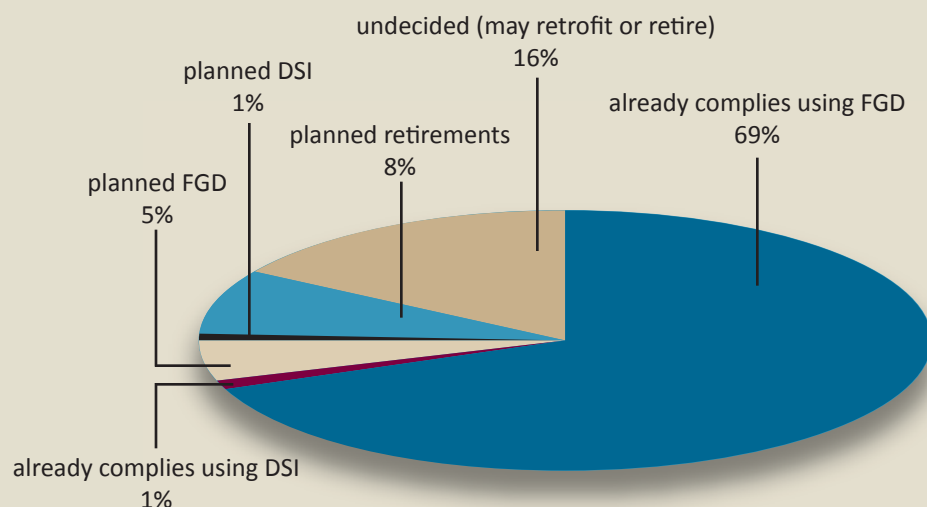
removal rate for SO₂ and other acid gases (90% of SO₂ emission for FGD, compared to 70% for DSI). DSI systems have much lower capital costs than FGDs, but significantly higher operating costs because of the high cost of the reagent needed to remove emissions.

The low capital investment required for a DSI system makes it easier to recover the investment in the controls if the plant is not expected to operate frequently. Installation of a FGD scrubber would require the plant to operate more often to earn enough revenue to pay for the significant capital investment.

At the end of 2012, 70% of the U.S. coal generating capacity already had the appropriate environmental control equipment to allow continued operation past 2016. Another 6% plan to add control equipment, while 8% have announced plans to retire. Owners of the remaining 16% are faced with the upgrade-or-retire decision.

Implementation of the MATS will result in significant reductions in SO₂ emissions from electric power plants.

MATS Compliance Strategies for U.S. Coal-fired Generation Capacity



Seventy percent of U.S. coal-fueled power plants comply with the Mercury and Air Toxic Standards.

FGD scrubbers have higher capital costs but lower operating costs than dry sorbent injection systems and are more suitable for baseload plants that run for long periods of time.

The outcome, 25 years after the Clean Air Act Amendments

SO₂ EMISSIONS FROM THE ELECTRIC POWER SECTOR DECLINED 67% BETWEEN 2005 AND 2012

The restrictions and air quality standards brought about *significant improvements in air quality*. Based on EPA's Air Trends^{iv} data, the national average of annual concentrations of sulfur dioxide decreased 84% between 1980 and 2011.^v This is good news.

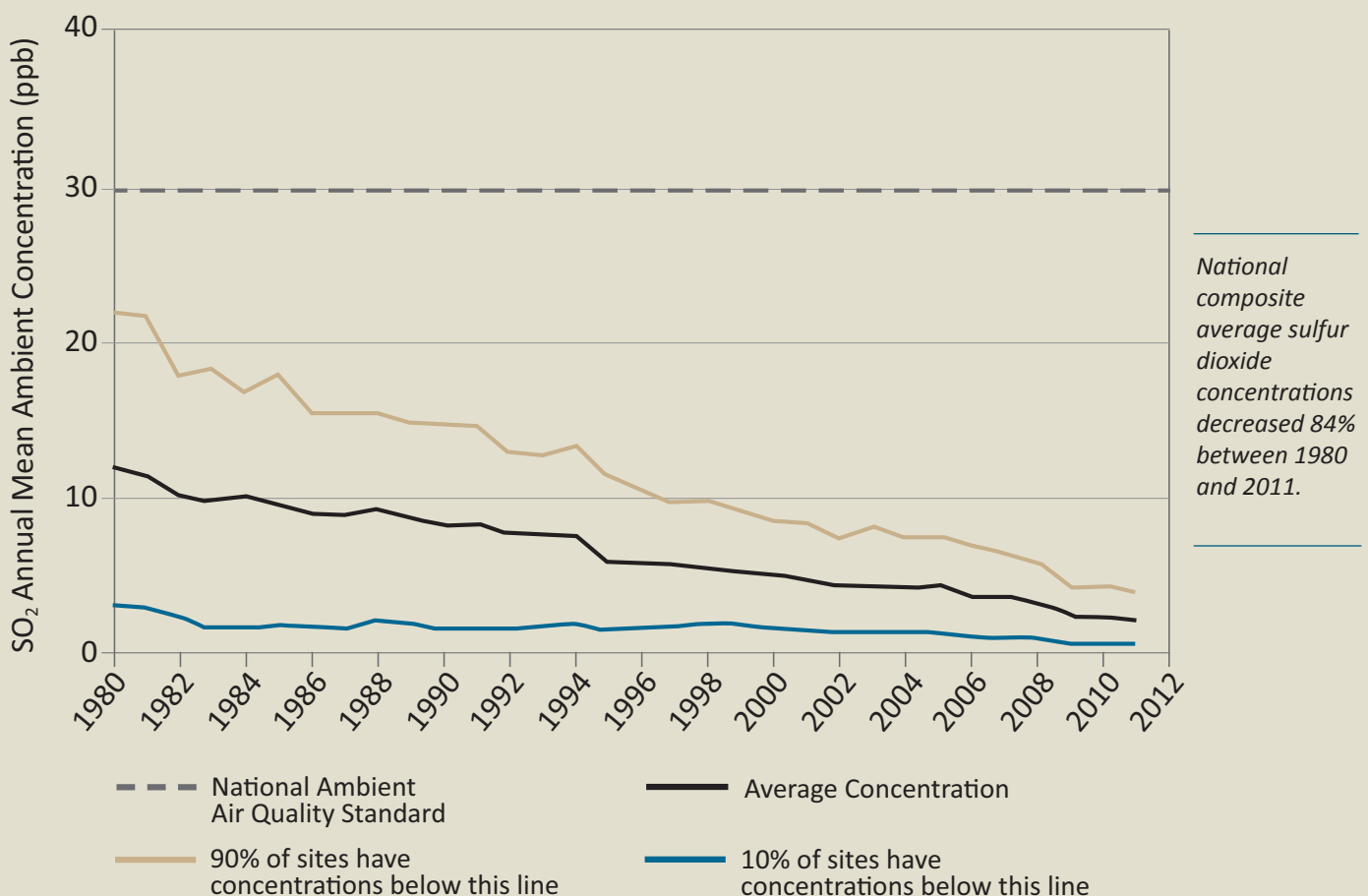
Since 1990, nationwide air quality has improved significantly for six common air pollutants: ground-level ozone, particulate pollution [particles 2.5 micrometers in diameter and smaller (PM_{2.5}) and particles 10 micrometers

and smaller (PM₁₀)], lead, nitrogen dioxide (NO₂), carbon monoxide (CO), and sulfur dioxide (SO₂).

SO₂ is one of a group of highly reactive gases known as "oxides of sulfur." The largest sources of SO₂ emissions are from fossil fuel combustion at power plants (65%) and other industrial facilities (16%). Smaller sources of SO₂ emissions include industrial processes such as extracting metal from ore, and the burning of high-sulfur fuels by locomotives, large ships, and non-road equipment.

SO₂ is linked with a number of adverse effects on the respiratory system. Data collected from monitoring networks show that the decline in SO₂ emissions from the power industry has improved air quality and reduced the ill effects on health.

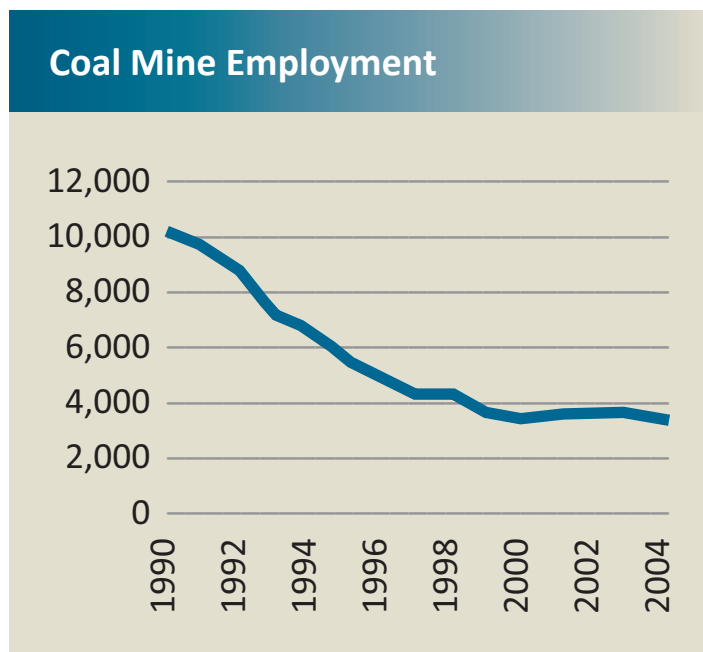
National SO₂ Air Quality, 1980–2011



Source: EPA, 2013

Enforcing the CAAA *burdened the Illinois coal industry*. By reducing the amount of sulfur dioxide from smoke stacks across the country, Illinois' high sulfur coal was no longer in demand by many large power plants in Illinois.

Without a demand for Illinois coal, mine employment plunged by 68%, from 10,129 in 1990 to 3,252 in 2004, and coal production declined 48%, from 61.6 million tons annually to 32.2 million tons.



Moving forward

As proven by Springfield City Water, Light & Power, Southern Illinois Power Cooperative and Prairie State Generating Station, and out-of-state coal-fueled electric generating facilities, emissions can be reduced while using Illinois coal.

Lower emission coal is possible with continued research, development and the demonstration of emission reduction coal technologies.

Adopting advanced coal technologies can provide base-load electric power that is both reliable and affordable. Setting goals with attainable deadlines and regulatory certainty, promotes research, innovation and sustainability on all fronts.

Endnotes

ⁱ U.S. Energy Information Administration, Monthly Energy Review Jan. 2014. Table 7.2b Electricity Net Generation: Electric Power Sector. Jan. 13- Oct. 13. http://www.eia.gov/totalenergy/data/monthly/pdf/sec7_6.pdf. Downloaded Feb. 5, 2014.

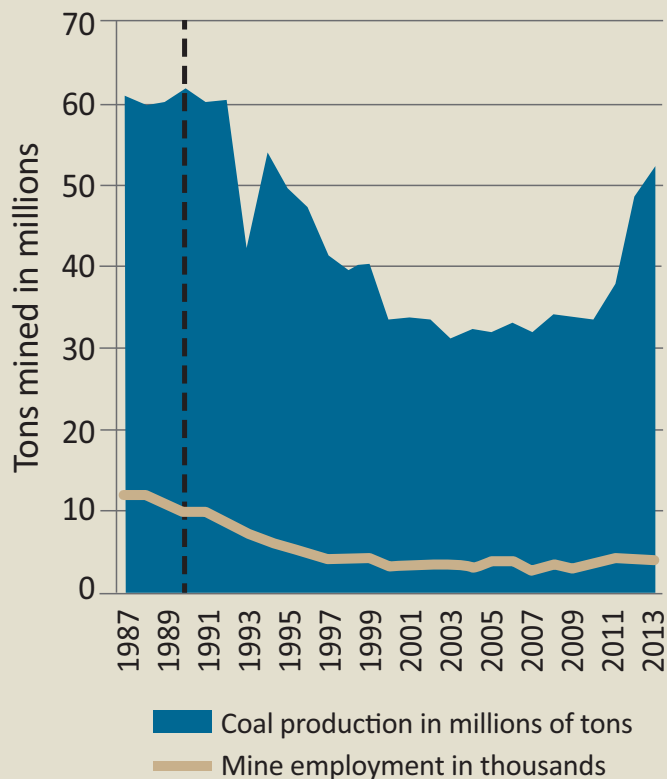
ⁱⁱ Institute for Energy Research. North American Energy Inventory. December 2011. Pgs. 23-25. <http://www.instituteforenergyresearch.org/wp-content/uploads/2013/01/Energy-Inventory.pdf>

ⁱⁱⁱ U.S. Energy Information Administration. Coal Data. Imports, Exports, Distribution. Annual reports http://www.eia.gov/coal/distribution/annual/pdf/o_12state.pdf

^{iv} U.S. EPA. Our Nation's Air. <http://www.epa.gov/airtrends/2011/report/no2coso2.pdf>

^v U.S. EPA Clean Air Markets. http://www.epa.gov/airmarkets/progress/ARPCAIR11_02.html#fig_history. Dec. 11, 2013

Historical Coal Mine Production & Employment



It is noteworthy that Illinois coal production is on the rise once again, to fuel power plants like many across the Southeast, that have installed emission reduction technology. Illinois coal exports are also increasing as India and China strive to close the gap of energy poverty for their citizens. The push for near-zero emission coal-fueled power generation is paramount.

- *Coal is abundant.*
- *Coal is accessible.*
- *Coal will be used for electric generation around the globe for the foreseeable future.*
- *Reducing emissions while using Illinois coal is our focus at DCEO.*



Illinois
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OFFICE OF COAL DEVELOPMENT

